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AND ABSTRACT OF THE LITERATURE

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HONORARY CONSULTING EDITOR
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Common Colds in Relation to Industrial Hygiene

Infectious Arthritis of the Spine

Some Observations on the Epinephrin Hydrochloride Test (Goetsch Test) in a Group of Normal Individuals

Lighting and Ventilation of Factories, Hours of Labor and Health

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THE JOURNAL OF INDUSTRIAL HYGIENE

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COMMON COLDS IN RELATION TO INDUSTRIAL HYGIENE*

HAROLD G. TOBEY, M. D.

Boston, Mass.

IT is generally recognized that the common "cold in the head" and its sequelae are among the most frequent causes of loss of time from work. The common cold as a disease is rather held in contempt by the average individual. As far as his experience goes it is a more or less limited, harmless process and something to be endured with what equanimity one can muster. His experience does not include the possible sequelae which may occur and which may cause serious loss of time, health, and even death.

In industrial life a great many of the common colds are rather an irritative process set up by unfavorable surroundings—*e.g.*, exposure to chemical irritants, cold, dampness or extreme heat—necessary to the particular occupation at which the individual is employed. Prolonged exposure to such conditions does, to be sure, render the individual susceptible to infection.

SYMPTOMS

Properly speaking, the term "cold" should be reserved for a particular disease with definite symptoms,—a disease which Dr. Wendell Phillips† describes as follows:

> An attack of acute rhinitis [or cold in the head] is usually ushered in by sneezing and a sensation of nasal stuffiness or obstruction. The obstruction is associated with a burning sensation in the nose, tenderness over the forehead upon pressure, heat in and below the eyes, lachrymation, a general sense of dryness of the mouth and throat, and often perversion or absence of the sense of smell and taste. Soon after the onset, the general symptoms supervene, such as languor, fatigue, chilliness and prostration. The general disturbances may be slight, but very commonly they are prolonged and distressing on account of the predominance of one or more of these manifestations. After a few hours the nasal obstruction becomes associated with a profuse watery discharge and the mucosa which was at first hyperemic becomes so much infiltrated that one or both nostrils may become entirely occluded. The nasal obstruction commonly alternates from one nostril to the other. The serous exudate soon changes to a mucopurulent and therefore thicker discharge as a result of the increasing admixture with cellular elements, and meanwhile it diminishes in quantity. The discharge often possesses an irritating quality which produces excoriation of the skin about the nasal orifices and upper lip. There may be a slight rise of temperature and

*Received for publication Nov. 15, 1921.

†Phillips, W. C.: Diseases of the Ear, Nose and Throat, Medical and Surgical. Fifth revised edition. Philadelphia, F. A. Davis Company, 1919, p. 493.

considerable loss of appetite. . . . Mouth-breathing is the rule, especially during sleep, resulting in great dryness of the pharyngeal and laryngeal mucosa . . . The swelling of the mucosa gradually subsides, and the secretion slowly diminishes and finally disappears; the attack usually terminates after a week. . . .

Such is the picture of the true cold in the head with which we are all familiar. It is necessary to have these symptoms well in mind in order to differentiate between the true infections and the cases of acute rhinitis, or coryza, from other causes, which never go on to pus formation unless infection supervenes.

Modes of Infection

Two avenues of infection are recognized:

1. It is well known that potentially pathogenic bacteria may lead a saprophytic existence upon the pharyngeal mucous membrane of healthy individuals. Under appropriate circumstances, these bacteria become the active agents of infection. Many causes may be enumerated for the lowered resistance which opens the door for active infection —such as, for example, physical exhaustion from overwork, dissipation or disease, and the deterioration of health which follows prolonged association with insanitary surroundings. As examples of important insanitary conditions predisposing to infection, vitiated air, overcrowding, defective diet, sedentary habits and neglect of body cleanliness may be mentioned. Prolonged chilling of the body from constant drafts may result in a temporary lowering of resistance, during which the bacteria may gain a foothold and acute infection develop.

2. A more frequent avenue of infection is by direct contagion from a person in an acute attack, in which instance there is a direct implantation of pathogenic bacteria. The chance of infection will depend upon the virulence of the bacteria and upon the general condition of the individual as well as upon the local condition of the upper respiratory tract. It is evident that individuals subject to the conditions mentioned in the previous paragraph are much less able to resist such contagion, which is carried by sneezing, coughing, embracing, speaking at close range, and possibly by towels, drinking cups and other utensils.

Surroundings favorable to contagion are found in ill-ventilated rooms, halls, or places of work, and in the close contacts necessitated by crowded trains and trolley cars. It has been found that in hot, dry, crowded rooms, such as ill-ventilated theatres or meeting halls, the mucous membranes over the turbinate bones and nasal septum swell, become turgid with blood and tissue lymph, and covered with thick secretion. In such crowded places massive droplet infection is likely to occur. On going out into cold, moist air, the blood vessels constrict and the nasal mucous membrane becomes chilled but remains swollen with tissue lymph. This condition of the mucous membrane affords a suitable condition for bacterial proliferation. Such an explanation is in harmony with the increase in incidence of upper respiratory diseases during the cold weather.

Treatment

Prophylaxis.—The following suggestions for the general care of the body will be found helpful in preventing attacks of cold in the head: Lead as vigorous and healthful a life as possible with adequate sleep, food, exercise and fresh

air. Bathe daily. Keep the house sufficiently warm to be comfortable but not overhot or overdry. Avoid contagion from infected persons, remembering that respiratory diseases are communicated chiefly through droplets of mucus sprayed into the air through coughing, sneezing and speaking. Avoid crowding in hot atmospheres.

General and Local Treatment.—Treatment may be divided into three stages to correspond to the stages of the infection: (*a*) measures directed toward aborting the infection in the prodromal period; (*b*) relief from the profuse discharge and turgescence during the acute stage; (*c*) oversight of the last stage in order to hasten the recuperative process and to forestall complications.

(*a*) As has been mentioned, it is extremely difficult to induce persons suffering with an acute cold to submit to the form of treatment which mitigates its severity, lessens its duration and almost surely guarantees immunity from troublesome and even serious complications. In the majority of cases the prodromal symptoms are not recognized and relief is not sought until the disease is well established. If these symptoms, such as dryness of the mouth and throat and even of the nose, a sense of stuffiness in the nose, headache, etc., are recognized, a hot bath, a hot lemonade and ten grains of Dover's powder followed by a saline cathartic in the morning will often abort or distinctly decrease the severity of the attack. This treatment is more efficacious if the person will consent to remain in bed, or at least in the house, for two or three days, and possibly repeat the above treatment on the second day. It is important to remember that this treatment is only to be instituted upon retiring, as the object is to induce a profuse perspiration.

(*b*) Opinions differ as to the advisability of local treatment during the acute stage; the dangers of irrigations and sprays are magnified, and well so, as indiscriminate and unskillful douching and spraying often lead to untoward results, spreading the infection to quite as great a degree as they remove it.

The chief indications for treatment are the profuse discharge and the swelling of the mucous membrane. The watery discharge may be controlled to some extent by the administration of belladonna in the tincture, ten drops every two hours until a sense of dryness is noticed. Belladonna and camphor are the principal constituents of the common rhinitis tablets which, while not curative, give some relief when properly administered. For the temporary relief of the turgescence of the mucous membrane, the local application of adrenalin in the form of a light spray, in the strength of 1:5,000 will prove the most useful. The resultant shrinking of the lining membrane allows a more thorough removal of the excess secretions. If, after the tissues have contracted, an oily spray containing menthol and eucalyptol is used, an added sense of relief is produced. Forcible spraying in ignorant hands is worse than no spraying at all. The vogue of aspirin among the laity extends, of course, to the common cold. All that can be expected of this, however, is to relieve the headache.

(*c*) In the last stage the secretions have become thick and adherent and are difficult to expel, the more so if irregularities of the septum are present, around which the secretions collect. The presence of these retained secretions keeps up the inflammation and infection which may gradually extend to the accessory sinuses, and it is therefore good practice to aid in their removal. Shrinking the turbinates by use of the adrena-

lin spray may be followed by a bland wash which mechanically removes the thick mucus. This washing should be done by an experienced person, in one of two ways: first, under direct inspection with a hand atomizer which throws a small non-forcible stream; or, secondly, by means of gravity from a douche bag. If the first method is chosen the fluid is heated to body temperature, the patient directed to hold his breath, and one portion of the nasal cavity is washed, immediately after which the head is thrown forward over a basin and the fluid is allowed to drain back. After all excess of fluid has been removed, the opposite nostril is closed with the finger, and the remaining fluid with the washed off pus and mucus is forcibly expelled. By the gravity method the same process is gone through with, excepting that the head is thrown forward during the whole performance. This method is not, of course, carried out under direct inspection. Coughing, gagging and swallowing while excess fluid is present must be guarded against. Such difficulties are usually occasioned by a fluid of improper temperature or by the patient's breathing during the operation and thus allowing the fluid to escape into the oropharynx or even into the larynx.

It is axiomatic that no irritating fluids should be used as they only increase the inflammation. Any irrigating medium in sufficient strength to kill bacteria will result in increased irritation of the nasal lining. It must be emphasized that it is only the mechanical removal of the irritating secretions that is desired. Non-irritating, simple alkaline washes, such as liquor alkalinus antisepticus (N.F.), or normal physiological salt solution, may be used for this purpose. (The latter is simply one teaspoonful of salt in a pint of water, and is absolutely non-irritant.)

Complications

The nasopharynx is almost invariably involved in every case of cold, and an associated acute tonsillitis is common. The infection may also extend to the larynx and to the bronchi. In certain individuals an attack of the common cold predisposes to prolonged bronchial inflammation. Infection of the accessory sinuses may occur in the early stages, particularly during a virulent infection. This is especially true of the influenzal infections. Acute involvement of the sinuses is indicated by severe pain and prostration. Persons thus affected are confined to bed and do not, as a rule, come under the care of the industrial clinic.

I wish to lay particular stress upon the colds which do not clear up after ten days to two weeks. In cases of this kind we are probably dealing with retained secretions—a subject which I have already discussed—or with a sub-acute infection of the accessory sinuses. Sub-acute infection of the accessory sinuses is usually indicated by a continual discharge from the nose. The discharge is more likely to be unilateral, since one side of the nose is involved more frequently than both sides together. Contrary to the usual idea, pain is not a necessary accompaniment of sub-acute sinus infection. Frequently the antrum, or maxillary sinus, acts as a reservoir for residual pus from the infection. The typical picture of such a condition is presented by persons giving a history of having had a cold two to four weeks before, which has not cleared up. There is a constant one-sided nasal discharge, and the head feels dull and heavy. The person cannot think or concentrate, there is a feeling of lassitude, the voice has lost its reso-

nance. Individuals complaining of these symptoms should be referred to a specialist, as very simple procedures will give relief; neglect frequently means loss of efficiency and, later, further loss of time from more radical procedures which may become necessary.

The common cold may be complicated by deafness and abscess of the middle ear, resulting either from direct extension of the process to the eustachian tubes and thence to the middle ear, or from the forcing of infected material into the tubes through careless douching and spraying of the nose. Inexpert use of the handkerchief during an attack of cold may result in infection of the sinuses or the middle ear. The act of wiping the nose with the handkerchief before one has finished blowing is almost a universal habit. This results in raising the pressure in the nose and nasopharynx and in forcing infectious material into the sinuses and eustachian tubes. We may well take a lesson from the laborer who closes one nostril while clearing the other; this may perfectly well be done while using the handkerchief. For the same reason, too, forcible blowing to expel secretions should be guarded against.

Considerable emphasis has been laid upon the common cold and its recognition, as it is frequently mistaken for acute rhinitis, or coryza, and vasomotor disturbances. An acute rhinitis, or coryza, is a temporary turgescence of the nasal mucous membrane, often accompanied by sneezing and a profuse watery discharge. Thus far, it resembles the common cold; but careful questioning does not bring out a prodromal stage of dryness or tickling in the nose or throat; there is no general lassitude, chilliness nor headache. The symptoms begin suddenly, last for a few hours, and disappear as suddenly as they appeared. In other words, while the way is paved for infection, such infection does not occur. These attacks result from various causes. Attendance at the theatre, or other gatherings where the air becomes vitiated and filled with dust, frequently gives rise to such a train of symptoms, which may last from twelve to forty-eight hours. Exposure to irritating chemicals and dusts in the industries may be the cause. Exposure to cold and to drafts gives rise to a temporary vasomotor disturbance. Any drug, such as aspirin or rhinitis tablets, taken at this time, is promptly proclaimed as curative. This is probably one reason why so many and various drugs have been advised for treatment. The essential difference, then, to be remembered between the common cold and acute rhinitis is that, in cases of the latter, infection does not occur.

With these conditions in mind, it becomes evident that irritating antiseptics and gases should not be used as a routine for these symptoms. Not infrequently such procedures set up a true inflammatory process in the nasal chambers upon which infection is bound to occur. The formalin chamber, to my mind, is not good treatment. Formalin is a very active irritant to the mucous membrane and, in sufficient concentration to be bactericidal, cannot be tolerated by the human body.

Recent studies in anaphylaxis have shown that prolonged vasomotor disturbances, simulating colds, may be caused by various substances which are ingested or inhaled. Hay-fever is the most common example. Certain individuals are susceptible to the dust inhaled from horses, cats, dogs, and feathers, or to various foods which are ingested. Chemists working in drugs, as well as workers in leather, may be susceptible. Face powder is frequently at

fault. Persons thus affected complain of prolonged colds with nasal obstruction, sneezing, and profuse discharge.

Summary

1. Every person complaining of nasal obstruction, sneezing and discharge is not suffering from a cold in the head. Learn to differentiate.

2. A careful history will be helpful in the diagnosis. The duration of the symptoms will indicate to a certain extent the character of the affection. A long duration points to a complication or to some disturbance which is not a cold. Inquire into the character of the person's work, the conditions under which he works, etc.

3. Differentiate the three stages of a cold and treat the patient accordingly. Do not use irritating antiseptics at any stage.

4. Any case resisting treatment for from two to four weeks should be examined by a rhinologist.

INFECTIOUS ARTHRITIS OF THE SPINE*

J. F. Curran, M.D., and S. F. Foster, Statistician

Norton Company, Worcester, Mass.

Introduction

THE detection and treatment of cases of infectious arthritis localized in the spine compel the interest of the industrial physician for two important reasons: (1) the insidious character of the disease with attendant difficulty of diagnosis and treatment; (2) the economic aspect as presented in the direct cost and disability to the victim and the indirect cost to the employer. The course of the ailment is characterized by progress without outward symptoms until a stage is reached when an act of overexertion causes severe pain and thus reveals the disorder. Preventive measures are then impossible and a long period of expense for employee and employer follows.

The incidence of cases of this disease is not large, thereby limiting the development of means by which it might be readily detected upon entrance examination. Proper placement in most cases would have permitted the employment of the patient for a considerable period upon work which was suitable. Instead, disability occurs and expense begins. It is admitted that, in the last analysis, the function of the industrial physician is to lessen production costs due to illness by prompt analysis and treatment of both major and minor ills. That this end may be served, information based upon special cases has been compiled as to the general nature of the disease, and as to special characteristics brought forward by the cases under observation.

*Received for publication Dec. 1, 1921.

Etiology

Infectious arthritis is an inflammation of a joint caused by the presence of bacteria or their toxins. Localization in the spine is, of course, subject to the same causes which produce the disease elsewhere. Lessened local and general resistance promote the activity of the bacteria and affect the progress through the various stages of the disease. A guide to the focus of infection may be tonsillar inflammations, past or present, the condition of the teeth, or the symptoms of a discharging sinus. The condition of the prostate, the seminal vesicles, and the gallbladder should be investigated. There is also the contributing factor of defective assimilation resulting in the absorption of toxins from the large intestine. The X-ray is invaluable in detecting the source of infection.

Pathology

The pathology of infectious arthritis of the spine may be classified into three stages, the progress from one to the other depending upon the severity of the disease and the physical resistance of the patient. The first stage, which is present in the milder cases, consists of a slight inflammation of the synovial membrane within the joint. In the more severe cases, erosion of the intervertebral disk occurs, and in the most serious cases there is destruction of the vertebra itself. In determining the pathology of the disease, the X-ray is of great importance. By proper control of the development of the negative, lesions in

the soft parts may be discerned and the stage of destruction or erosion of the cartilages in the affected area can be determined.

Clinical Course

Cases of infectious arthritis of the spine are revealed chiefly by routine examination or by an industrial accident. The onset is usually acute, and patients report that prior to an act of overexertion they were in good health. Accompanying the strain is intense pain as the muscles which have been serving as a support assume a state of tonic contraction to prevent further irritation or injury. Rigidity, the military or poker back, quickly develops, and any movement occasions a considerable amount of pain. It is apparent at once that the physician is confronted by a serious problem and he is handicapped unless there has been physical examination or history of disease or injury referable to the spine.

Treatment

The purpose of treatment is to eradicate the source of the disease and to apply support and corrective measures to the diseased area. Examination is made for all possible foci of infection, and wherever any focus is found remedial measures are administered. A plaster jacket so designed that the muscular support will be relieved is applied at once. When it becomes obvious that the disease is in a quiescent state, the patient may be equipped with a spring back brace and permitted to return to employment.

Report of Cases

The cases of infectious arthritis of the spine to be presented have been selected as representative of the characteristics of the disease. They illustrate the extensive cost of this sort of disability and the almost certain resulting incapacity for ordinary forms of employment. Cases of this type are of serious concern to the industrial physician because he bears a responsibility to his employer in the control of the physical well-being of the operating force which should result in the prevention of excessive disability costs. From the purely professional point of view, the disease is of especial interest because in the early stages when it is most amenable to treatment there are few, if any, symptoms. An accurate diagnosis is complete only when the clinical diagnosis is corroborated by the X-ray. The value of information relating to infectious arthritis of the spine from the standpoint of the employer and employee is self-evident.

In outline, therefore, the importance of the affection to those involved appears as follows:

1. *To Employer:*
   (*a*) Effect on premium rate
   (*b*) Cost of treatment and management of case
   (*c*) Production delays by absence of employee
2. *To Employee:*
   (*a*) Long disability
   (*b*) Great suffering
   (*c*) Loss of wages
3. *To Physician:*
   (*a*) Difficulty of diagnosis
   (*b*) Difficulty of treatment
   (*c*) Responsibility to employer and employee

The points thus shown are exhibited in the cases which follow.

Case 1.—S. B., a Greek workman, aged 35.

History.—On November 28, 1917, S. B., a Greek of relatively sturdy physique, being 5 feet 2 inches tall and weighing 123 pounds, suffered a back strain while in the act of pushing an industrial truck. The extra exertion required to move the truck over a doorsill occasioned the strain. Upon examination when he was hired, this man was considered physically capable of performing the work to which he was assigned.

After receiving treatment he resumed regular work on December 3, 1917, and continued until December 17, 1917, when he was compelled to stop work because of the severe pain in his back. During this period, daily calls were made at the company hospital where local treatment was given.

Complete disability continued until April 3, 1918, when the patient returned to work as elevator operator, a task which required little exertion. Excessive pains in the back caused him to stop this work April 11, 1918. He remained idle until May 8, 1918, on which date he was again placed in the position of operator of an elevator equipped with automatic gates and electrically propelled. A minimum of effort was therefore required. He was forced to stop this work on July 2, 1918, and up to the date of writing has not been employed.

Physical Examination.—At the time this man was hired there was no marked evidence of physical weakness. Slightly defective vision in one eye, moderate right septal deviation, teeth fair but neglected, first degree herniae, were the only defects recorded. Shortly after the injury there was tenderness in the lumbar region and motions in all directions were markedly limited and painful. The patient stood with distinct list to the right and there was an area of rigidity involving the tenth dorsal to the fifth lumbar vertebrae.

X-ray Examination.—The negative showed evidence of hypertrophic arthritis involving all the dorsal and lumbar vertebrae.

Treatment.—In the early stages, symptomatic relief measures were applied, consisting of baking, massage and strapping. Later a plaster jacket was applied and worn by the patient for eight weeks. Permanent equipment in the form of a steel brace was then supplied and the patient when last observed was still dependent upon its use. The focus of infection seemed to lie in the teeth to which remedial measures were applied. The patient was also given general tonic treatment as his suffering occasioned much loss of weight and strength.

Results.—From the day of the accident until the present writing the cost of this disability has been approximately $2,200, and in all probability the full legal amount of $4,000 will be expended. In addition, the Associated Charities have rendered considerable financial support. The patient has suffered complete incapacity for all ordinary forms of work and will be a constant hazard to himself and to his employer in even the milder types of labor.

CASE 2.—C. B., an Italian workman, aged 33.

History.—C. B., an Italian with the average physical development of men of this race, 5 feet 4 inches in height and weighing 140 pounds, wrenched his back while delivering coal on October 5, 1920. His routine occupation was that of trucker, at which he had been employed for two years, and it was in the course of his regular work, as he was emptying a 100-pound bag of coal through a window in a shed, that he experienced severe pain in the lumbar region.

The patient, although suffering considerable pain, was able to continue work that day. The pain became more severe, however, and medical attention was sought. Treatment for back disorder was administered but up to the present time the patient has been forced to remain idle.

Physical Examination.—The patient appeared fairly well developed and nourished, and showed no peculiarity aside from the condition of his spine. There was a marked list to the left in his posture, together with evidence of lower dorsal and lumbar left scoliosis. Motion was restricted to about half normal in all directions, and there was no appreciable backward movement below the tenth dorsal vertebra.

X-ray Examination.—X-ray examination was conducted by three different physicians. In the views furnished by two of these physicians, there appeared left lumbar scoliosis, while the negatives from the third presented both scoliosis and infectious arthritis of the second lumbar vertebra manifested by considerable destruction of the body.

Treatment.—The usual measures for relief—namely, strapping, massage and baking—were administered but the patient continued to suffer severe pain. A plaster cast was then applied and allowed to remain in place six weeks. At the expiration of this time, a spring brace was provided for permanent use. The focus of infection could not be located, and the patient denied ever having suffered venereal disease.

Results.—Since the day of the accident, no work of any description has been performed by the patient. In all likelihood, this is a case of permanent disability and will entail a considerable sum for settlement. Already $1,200 has been expended for compensation and medical care.

CASE 3.—F. W., an Irish workman, aged 19.

History.—On August 13, 1919, F. W., a strong, well-built man, strained his back in lifting rods of iron from a truck to an elevator, an act which was in the course of his routine occupation. He continued to work

for two weeks, then he was forced to discontinue by reason of the severe pains in his back.

Remedial measures were applied and the patient returned to work in March, 1920, but was only able to continue for two weeks. Since that date he has remained incapacitated for ordinary forms of labor.

Physical Examination. — The patient presented a large, over-developed condition in relation to his age, being 17 years old and weighing 170 pounds. On general examination, no peculiarities were observed except that the teeth were irregular and neglected and hallux valgus was present on each foot.

The patient stood very erect and the natural lumbar curvature was absent. The legs were equal in size by actual measurement, but there was considerable stiffness in the right hip. Motion was restricted in all directions, there being practically no movement in the lumbar region, while a slight flexion was possible in the dorsal region. Lateral motion to the left appeared more painful than to the right.

X-ray Examination.—Negatives gave evidence of chronic arthritis involving particularly the fifth lumbar vertebra. The transverse process of the vertebra had been destroyed.

Treatment.—The patient was strapped but no relief was afforded. A plaster cast was then applied and worn by the patient for four months. He was then fitted with a spring brace which has become of daily necessity. No focus of infection could be isolated.

Results.—The patient has remained up to the present time incapacitated for all forms of ordinary work and has been receiving $16 per week compensation, which has amounted to approximately $1,700. It is expected that a lump sum settlement will be advanced. The patient, however, will always be a dangerous risk both to himself and to his employer.

Summary

These cases illustrate the need of particular care by industrial physicians in examining the backs of all employees. Infectious arthritis of the spine is exceedingly expensive both to the employer and to the employee, and is a baffling problem to the industrial physician.

Many times, trivial accidents involving the back are treated as muscular strains, which would be the natural diagnosis from superficial examination. In order to arrest early the more serious disorder of infectious arthritis it is good practice to X-ray all cases where there is the least suspicion. It is possible that the X-ray may be negative even though the patient exhibits the unmistakable signs of local tenderness and rigidity. Reliance upon the X-ray in the majority of cases, therefore, demands positive evidence.

Prompt detection is of assistance in locating any foci of infection, as it permits the application of corrective measures which will improve the patient's general condition.

From every angle, the desirability of better control of infectious arthritis of the spine is manifest. Upon the physical examination at the time of hiring workmen rests the responsibility for the exclusion from employment of serious risks of this nature. Particular attention must, therefore, be directed to the condition of the joints; flexion of the trunk and limbs must be required, and other tests must be applied to bring out any signs of infectious arthritis. When there is reason for suspicion, examination should be carried further by means of the X-ray.

The duty of the industrial physician, in a word, requires:

1. More attention to the condition of the joints at the time of entrance examination;

2. Prompt and exhaustive analysis of back strain to detect immediately cases of infectious arthritis;

3. Prompt treatment to the focus of infection in an endeavor to eradicate it, and adequate treatment to the diseased area.

The effects of this disease are sufficient to warrant these precautions.

SOME OBSERVATIONS ON THE EPINEPHRIN HYDROCHLORIDE TEST (GOETSCH TEST) IN A GROUP OF NORMAL INDIVIDUALS*

WILLIAM P. VAN WAGENEN

TO Dr. Emil Goetsch we are indebted for the correlation and practical application of the physiological observations of Oswald (1) and Levy (2) that an increase in the active principle of the thyroid gland enhances the pressor action of epinephrin. The principle of the original observations of this writer has been substantiated many times. From time to time, however, there have been reported variations in the percentage of positivity of this test in cases of clinical hyperthyroidism. The doubts of Dr. Martin B. Tinker, of Ithaca, New York, regarding the validity of the observation that all cases of clinical hyperthyroidism give a positive epinephrin hydrochloride test — very severe and long standing cases excepted—led me to undertake to verify this observation on some sixty of his cases of hyperthyroidism, clinically so diagnosed, in the Ithaca City Hospital. There were two cases which, to the best of my interpretation, gave a negative result with this test. Reference to six similar cases of Peabody's will be made later. In the same series there were four cases concerning which there was a good deal of doubt as to the diagnosis of hyperthyroidism. History, physical findings, and the therapeutic test of rest in bed were all negative; unfortunately, basal metabolism determinations could not be obtained. The epinephrin hydrochloride test, however, was positive.

An experience of this sort is not unique. Woodbury (3) reports eleven patients who reacted positively to the epinephrin hydrochloride test but who had basal metabolisms considered to be within normal limits. They did not show any improvement of clinical symptoms on rest. The histories and clinical symptoms, however, were typical of hyperthyroidism and the cases were diagnosed as hyperthyroidism, in spite of normal basal metabolisms and the result of rest, because of the clinical pictures and histories, the histological examination of the glands and the post-operative results. While the diagnosis in Woodbury's cases is doubtless correct because of the recent increase in the size of the goiter, the nervousness, tremor, dyspnea, palpitation, and loss of strength, I question a diagnosis of hyperthyroidism on the basis of an increase in the height and size of active cells, with infolding of walls of the acini and a decrease of colloid. Goetsch (4) states that in about 20 per cent. of a series of his cases diagnosed as hyperthyroidism the pathologist failed to associate the histological findings with the clinical course of the disease. Likewise, a post-operative condition at a period of from six weeks to eight months after operation is not necessarily the final condition. A year is probably none too short a time in which to judge the lasting results of many cases of hyperthyroidism that come to operation.

Such observations as these of Woodbury's and my own led me to speculate on what percentage of normal individuals would react to the epinephrin hydrochloride test. Normal subjects for study with the Goetsch test were selected from Cornell University Sum-

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mer School students in the Department of Physical Education. A careful history was obtained from each student as to the possible existence of symptoms that a borderline hyperthyroid patient might show, fatigability, weakness, tachycardia, nervousness, loss of weight, etc., and the records of physical examinations of these students were consulted. A more physically fit, more symptomless group could not have been desired. So far as gross inspection showed, there were no cases of chorea, asthma, epilepsy, diabetes or dementia praecox which might account for a positive epinephrin hydrochloride reaction —an occasional occurrence, according to Peabody and his associates (5), in these conditions. Goetsch (6) adds to this list neurocirculatory asthenia. The differentiation of neurocirculatory asthenia from hyperthyroid states he makes on a family history of nervous instability and a slow gradual onset of symptoms, usually dating back before puberty, which the patient does not know he possesses. There was likewise no history of symptoms among this group that led me to suspect such a condition existed. A basis of this sort for ruling out neurocirculatory asthenia is obviously open to question.

In doing the tests, patients were required to lie quietly until the pulse rate, blood pressure reading and respirations were constant for at least fifteen minutes. Parke, Davis adrenalin hydrochloride was used. The potency of the drug was determined by injecting it intravenously into a cat and recording the blood pressure changes in the carotid artery; also by using the sample on known hyperthyroid patients with positive results. As soon as the patient was quiet and accustomed to his environment, an injection of 0.5 c.c. of adrenalin hydrochloride was given in the deltoid region. In fat individuals care was taken to make the injection as superficial as possible, since injection into the fat tended to obscure the local reaction or retard its appearance. Blood pressure readings were taken from the other arm every five minutes for one hour, together with pulse and respiration rates. Respiration varied so little that it is not included in the curves of other data.

The question of interpretation of results at once presents itself. Goetsch (4) considers a positive reaction to consist of a rise in pulse rate of at least ten beats per minute, and a rise in blood pressure of from 10-50 mm. Hg, together with a train of general symptoms and a local reaction to the drug. The general symptoms, as I found them, are in part objective, and in part subjective—*i.e.*, tremor of the platysma group of muscles of the hands and lower extremities, lachrymation, pallor of the mucous membranes and face, a feeling of weakness, tiredness, drowsiness, palpitation of the heart, throbbing of the aorta and neck and head vessels, a sense of constriction of the chest, white specks before the eyes and sometimes blurring of vision, and occasionally diuresis and urgency. When positive, Goetsch (7) considers such results to be practically diagnostic of hyperthyroidism. To quote from him:

> My epinephrine test depends upon the fact that in an organism in which there is an overamount of thyroid secretion present the sympathetic nervous system is sensitized to the action of epinephrine, and I have found after a study of over six hundred cases of thyroid disease that in clinical states of hyperthyroidism the patient reacts positively to the subcutaneous injection of 0.5 c.c. of one in one thousand adrenalin chloride solution, a dose to which a normal individual does not react.

From a practical point of view, Goetsch considers the test of considerable value:

> A positive test has helped me in determining whether the case is truly hyperthyroid and whether thyroidectomy should be done, or whether continuance of medical measures should be advised, and it is this positive test which has helped me so much in the fourth group, which I have termed diffuse adenomatosis and which before had been so baffling. I have advised operation also in the adenoma group in which the adenomata were too small to be seen or felt before operation . . . and have had splendid results from resection as has been shown in the post-operative study of these cases.

Goetsch (7) claims further that a negative test excludes hyperthyroidism except in a few very severe cases.

Peabody, Sturgis, Tompkins, and Wearn (5) make the pertinent suggestion that "a theoretically 'positive' reaction might indicate hyperactivity of the thyroid gland, of the adrenal glands or of the sympathetic nervous system. It might, on the other hand, depend on a lowered threshold of response of the sympathetic nervous system. With the exception of hyperthyroidism little is known of these conditions in man, but they probably occur and there would seem to be no reason for assuming that a 'positive' epinephrin reaction is constantly associated with hyperthyroidism." Their observations in instances of this will be referred to again later.

In interpreting my own results I have not considered as positive a test that did not show a rise in blood pressure and pulse rate of at least fifteen points, together with well-marked general symptoms. My experience with the local reaction in cases of known hyperthyroidism varies. In a positive local reaction there is a blanching of the skin over the epinephrin injection in about five to fifteen minutes, which persists from sixty to ninety minutes or longer. The blanched area is surrounded by a narrow zone of purple, or red or blue, presumably due to venous dilation. This outer zone varies a good deal in color from individual to individual and also in the same person. I am inclined to believe that a changeability of color of this outer zone is seen in the majority of cases of true hyperthyroidism, and is occasionally seen in normal cases giving positive tests.

In the fifty cases composing this series there were ten positive reactions, or 20 per cent. The criterion of a positive test, as mentioned previously, was the change in blood pressure, pulse rate and general symptoms, and the local reaction. The average blood pressure and pulse changes were as follows:

a. The average maximum blood pressure rise for the ten positive cases was 16 mm. (Fig. 1); for the forty negative cases, 9 mm. (Fig. 2); for the combined group, 10 mm. (Fig. 3).

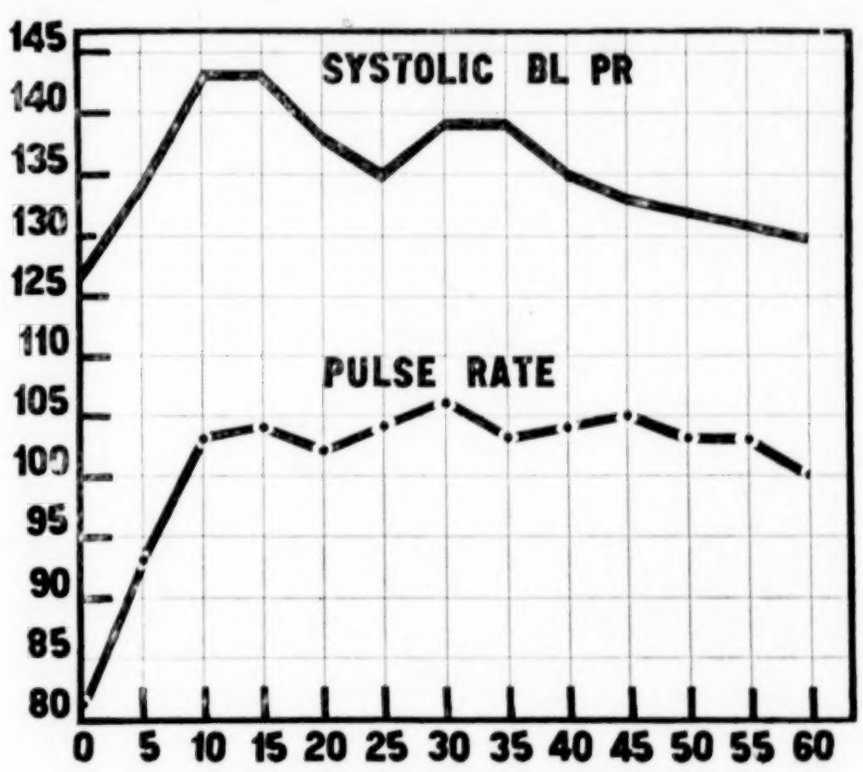

FIG. 1.—Composite curves of ten positive reactions to the epinephrin hydrochloride test among a series of fifty normals. Ordinates in these figures represent millimeters of mercury for blood pressure and pulse beats per minute. Abscissas represent minutes.

b. The average maximum pulse rate rise for the ten positive cases was 25 beats per minute (Fig. 1); for the forty negative cases, 13 beats per minute (Fig. 2); for the fifty cases (combined), 16 beats per minute (Fig. 3).

Inspection of the figures shows that

the maximum and minimum blood pressure rises were, for the positive cases, 38 mm. Hg and 12 mm. Hg in Cases 22 and 25, respectively. The pulse rate curves show a maximum and minimum rise, for positive reactions, of 68 beats per minute and 26 beats per minute in Cases 18 and 32, respectively. In the forty negative cases the minimum rise was 5 mm. Hg in Cases 5, 6, 24, and 31; the maximum rise, 40 mm. Hg in Case 3. The minimum pulse rate rises were 5 in Case 16, and 38 in Case 25.

An instructive fact to note is that the starting point in blood pressure readings and also in pulse rate for both positive and negative cases was essentially the same, *i.e.*, 127 mm. Hg in positive cases; 121 mm. Hg in negative cases; 81 beats per minute in positive cases; 80 beats per minute in negative cases. It cannot, therefore, be assumed that the positive cases primarily had tachycardia with heightened blood pressure as they might have in hyperthyroidism, either obscure or evident on clinical examination.

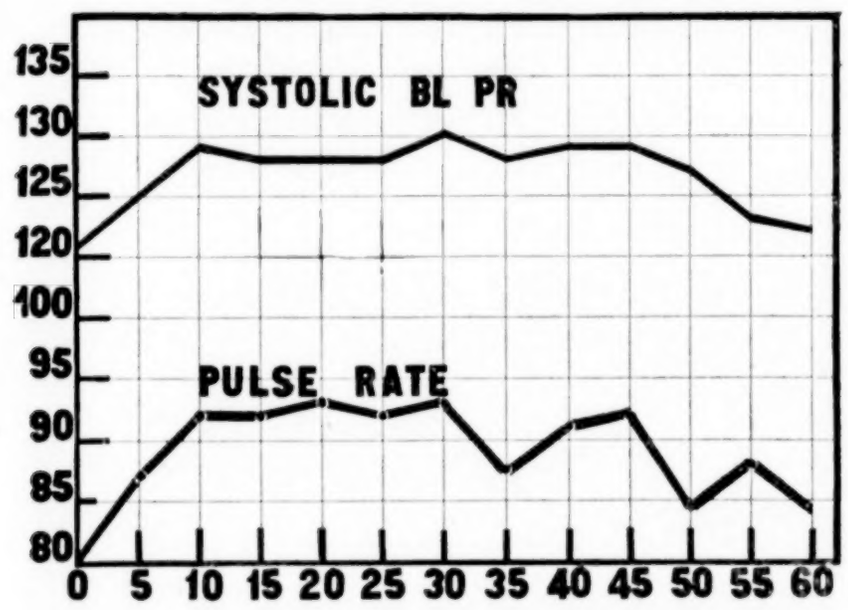

FIG. 2.—Composite curves of forty negative reactions to the epinephrin hydrochloride test.

Inspection of Figures 1 and 2 shows that the first maximum blood pressure rise in both positive and negative cases occurred approximately at the fifteen minute period. Likewise the secondary rises occurred together—at the thirty-five to forty-five minute periods. Both of these curves are essentially typical of the curve seen in animal experimentation when epinephrin is injected intravenously. The difference is quantitative only.

An admitted fault in the procedure is the failure to continue observations on each case for at least two hours, instead of one hour. It is instructive, however,

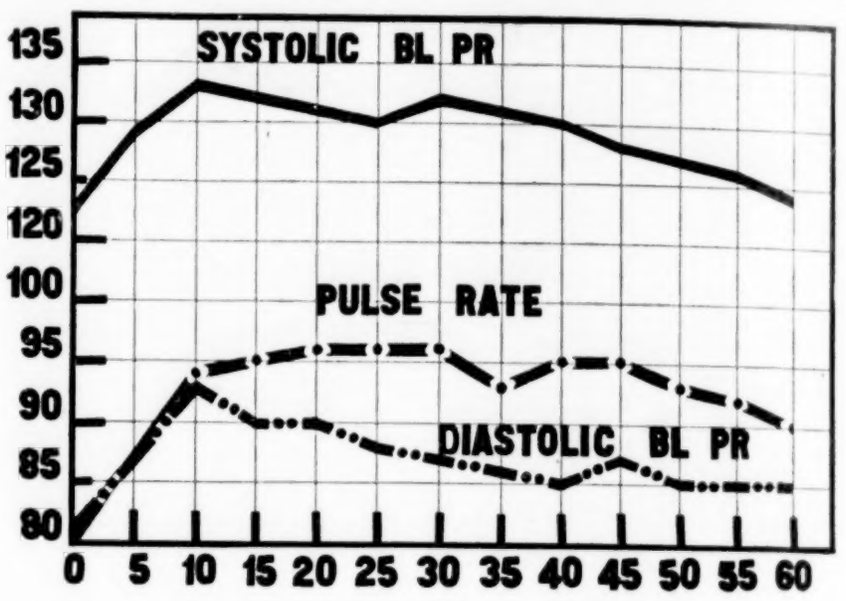

FIG. 3.—Composite curves of fifty reactions to the epinephrin hydrochloride test.

to note that the curve of blood pressure readings is as nearly back to normal in the positive cases at the end of an hour as in the negative cases. Had the curves of the two groups differed essentially in type, one might not expect this to be the case.

The pulse rate curves offer more difficulty of interpretation. In general, it may be said that in the positive cases the pulse rate rose to a maximum, or nearly so, in ten minutes, and was sustained at that level, with slight fluctuations, for the entire hour, having fallen but 6 points from the maximum in the sixty minutes. In the negative cases the pulse rate was more nearly back to normal, *i. e.*, within 8 points of the original. Figure 3 was made to show that the whole series of cases taken together—positive cases plus negative cases—gives a curve essentially of the same type as those shown in Figures 1 and 2, and similar to the curve of cases of known hyperthyroid reaction.

If one cannot combine pulse rate and blood pressure findings with general symptoms, I believe that the general symptoms are more valuable in determining a reaction. Tremulousness, beginning in the platysma group of muscles and also present in the hands and lower extremities, was the most constant symptom in my series, being present in all ten of the positive cases. A feeling of general weakness and tiredness was next in order of constancy, being absent in only one case. Seven patients complained of bladder urgency. There is, throbbing in the vessels of the head, neck and aorta. Lachrymation was present in three cases. One patient complained of bladder urgency. There is, of course, no means of quantitating general symptoms, especially subjective symptoms, except by their duration. In general, the positive cases gave symptoms lasting from thirty minutes to forty-eight hours—one case each—with an average of two hours. The negative cases, on the average, gave symptoms lasting from ten to thirty minutes. The severity of the general symptoms in negative cases, where any occurred, was always less than in the positive cases.

The local reaction was a distinct positive in four of the positive cases and in four of the negative cases; the blanching of the overlying skin occurred almost at once, the contraction of the erector pili muscles was prolonged over one hour and the peripheral zone of colors was variable, such as is seen many times in known hyperthyroid reactions. This feature of the test was the least satisfactory of any. With little subcutaneous fat and a coarse skin it works very well, but where the epinephrin is injected into the fat the results are more variable.

From the foregoing observations, admittedly small in number but done with great care, I am forced to express doubt regarding the diagnostic value of a test for hyperthyroidism in a "borderline case"—a test which is positive in 20 per cent. of a group of well, healthy, active, physical education students free from hyperthyroidism so far as history, symptoms and observation could determine; likewise free from psychoneuroses, neurasthenia, hysteria, and melancholia.

Peabody, Sturgis, Tompkins and Wearn (5), working among soldiers in camp, likewise present evidence which varies with the statement that no cases of hyperthyroidism fail to give a positive reaction, very severe and long standing cases excepted. In a series of twenty-one cases diagnosed as hyperthyroidism on the classic signs, symptoms and history, together with the determination of the basal metabolism, "six unquestionable cases, four in early stages and two in later stages with basal metabolism ranging between 21 and 35 per cent. above normal, gave negative reactions." Two such cases I myself have observed and have already referred to. Peabody and his collaborators find further that persons whom they consider as normal sometimes react positively to the test. Fourteen per cent. of a series of twenty-eight medical students gave positive reactions, and 17 per cent. of a series of seventeen cases of organic heart disease also responded positively to the test. These percentages accord fairly well with my own. Among 143 cases of "effort syndrome" also studied by Peabody and his collaborators 48 per cent. reacted to the test.

Summary

1. In determining a positive reaction to the epinephrin hydrochloride test the

results must be considered as a whole, but the importance of the findings may be grouped in the following order: general objective and subjective symptoms, pulse rate curve, the blood pressure curve, and, lastly, local reaction.

2. The curves for blood pressure are essentially of the same type in negative cases, in positive cases among normal subjects, and in known hyperthyroid cases, differing only in a quantitative way. The general symptoms, likewise, differ only in quantity in these various types of cases.

3. The 20 per cent. of this series of cases which reacted positively to the test make it seem unlikely that the test can always be relied upon in cases where clinical observation is unable to establish a diagnosis of hyperthyroidism.

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LIGHTING AND VENTILATION OF FACTORIES, HOURS OF LABOR AND HEALTH*

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MY experience in Tasmania as the first Chief Inspector of Factories in that state served only to confirm my previous experience so far as realizing that the average employer and employee are but little concerned with questions of health and sanitation.

I found that, on the part of the employer, there was much concern lest the introduction of wages boards and the payment of wages more on a par with those paid on the mainland would cripple industry, whereas, on the part of the employee, the chief points of interest were the securing of better wages and a reduction of hours of employment. Time and again it was pointed out — often, unfortunately, with truth — that attempts to improve the conditions under which men and women worked in factories were looked upon by them with mistrust or were actually resented as an unwarranted interference. One would find that ventilators would be blocked, sanitary conveniences fouled, and, generally, that the workers were content with the old order, or disorder, with regard to sanitation.

The War has, however, altered the outlook as far as the biggest and best employers are concerned. It is being realized more and more that the health of the worker is a factor of vital importance in maintaining energy, without which output readily decreases. To maintain health man requires fresh air, a good and plentiful water supply, sufficient food and clothing, adequate shelter, and, above all, conditions of cleanliness, with adequate periods for exercise and recreation.

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LIGHTING

In recent years much attention has been devoted to the provision of proper lighting in factories. Sunlight is not only essential to the maintenance of health, but is the only perfect light. Diffused daylight is, therefore, always to be recognized as the standard light. Generally speaking, however, it cannot be claimed that hitherto sufficient advantage has been taken to secure the benefits of diffused daylight and, indeed, the dead hand of the past seems still to limit window space. In remote times, before the discovery of glass, and later before its universal use, openings for light were restricted, while in still later times there was actually a window tax, which naturally discouraged the provision of adequate lighting.

In Australia, as is true in most of the newer countries, we have followed the conventional styles of architecture which obtained in Europe, all too oblivious as to their adaptability or suitability to the climate. Any departure from the conventional or traditional styles appears up to recent times to have been regarded with the suspicion of either being eccentric or not complying with the traditional so-called artistic taste.

We find that in ordinary dwellings as well as in factories there is often no attempt to adapt window space to the lighting requirement of the particular room. One sees uniform sized windows fixed in

dwellings where exterior obstructions interfere with the natural lighting, just as in dwellings where there are no obstructions. Moreover, there is often a failure to recognize the fact that even where there are no obstructions, the aspect and consequent natural lighting possibilities vary with the points of the compass. It is evident that the fixed rule as to the direct proportion between window space and floor space, such as 1/10 or 1/5, should only be taken as a minimum, and that such important factors as the nature of possible exterior obstruction, position of windows (vertical or horizontal), length and width of room, and angle of incidence of sunlight must be given due consideration. Otherwise, defective lighting will inevitably result.

The most effective natural light is obtained from a high window with splayed jambs, extending nearly to the ceiling, and situated near the center of the wall. It is impossible to get too much natural light, and it is noticeable that this fact has been recognized by the leading jewelry firms of Sydney, whose large workrooms, recently built, have practically one continuous window on each side. The best lighting effect in factories, especially in those of one story, is obtained from skylights, provided the roof is from 30 to 35 feet high. With roofs less high the glare from the direct rays of the sun and the intense heat of summer make this method unsuitable.

The modern tendency in cities to crowd high buildings on a limited space has necessitated considerable ingenuity in the provision of light areas. Even where these areas are painted white in order that every advantage may be taken of them, it is often necessary to resort to artificial lighting, which can never be considered a completely efficient substitute for daylight, and which is only justifiable when daylight fails, or under exceptional circumstances. I do not propose here, however, to discuss the relative merits of the various forms of artificial lighting. Certainly, as far as Hobart is concerned, with her splendid hydro-electric works and comparatively cheap power, electric lighting ought to hold the field.

From the fact that sunlight is the most satisfactory, the nearer we approach in artificial illumination to the reproduction of such diffuse white light, the better. We can, however, formulate the following essentials in lighting: a sufficiency of white light without excess; perfect steadiness; effective diffusion; freedom from violent contrasts; downward and preferably oblique direction. The source of light, which is usually the cause of trouble, should not be in a direct line with the eye, and in the case of brilliant lights it is important to have diffusion globes or other means of softening the glare. It is quite essential, too, that the light be steady; otherwise the eye is irritated by continuous and ineffective attempts at accommodation. Direct sunlight effects may be reduced by the use of blinds or, in factories and workshops, particularly, the light may be diffused by means of windows of ground or prismatic glass.

Sunlight is absolutely essential to the maintenance of health. Most people are familiar with the anaemic appearance, the limited vitality and the susceptibility to disease of those who habitually live or work under darkened conditions. Recently, in Sydney, I found an elderly woman and a child who had been living under conditions where they never got direct sunlight, and who consequently were blanched and bleached like celery.

When uniform lighting is desired, one foot candle can be obtained from:

1. *Electric Lighting*
   (*a*) Ordinary vacuum lamps 0.2 to 0.3 watt per square foot.
   (*b*) Gas-filled (half-watt) lamps 0.1 to 0.15 watt per square foot.

2. *Gas Lighting*

(*a*) Low pressure — 1 cubic foot per hour per 100 square feet illuminated.

(*b*) High pressure — 1 cubic foot per hour per 200 to 300 square feet, according to pressure employed.

The above figures assume direct lighting with scientifically designed reflectors and appropriate spacing. In general, the consumption will have to be increased 50 per cent. for semi-direct, and 100 per cent. for indirect lighting, in order to obtain the same illumination on the working plane, though more light may be directed into the upper part of the room. All globes, shades, and reflectors should be cleaned at regular intervals, varying from one to six weeks.

In modern factories there is a tendency to adopt overhead lighting from units in which half-watt lamps are used, mounted direct on the ceiling or girders. In order to keep the light out of the direct range of the vision of the operators and to make possible the alteration of machines without change of illumination, the walls should be lime washed and the machines painted green or slate gray. It is now possible for modern firms actually to plan an efficient lighting scheme by paying attention to correct spacing and distribution, and, by specifying the consumption of electricity per square foot, to forecast with accuracy the illumination which will be produced on a working plane.

With indirect lighting the source is completely shaded, the rays being reflected on the ceiling, whence they are diffused throughout the room. An excellent effect is obtained in the lighting of the Lord Mayor's room at the "Mansion House," London, which was one of the first places in which this new method of lighting was introduced. This method eliminates glare, gives soft shadows, and at the same time causes light to penetrate to every corner of the room. It requires a higher degree of illumination, however, and is not suitable for factories where pillars or girders interfere with reflection from the ceiling.

Semi-direct lighting, where part of the total lighting is simply diffused by the bowl of the fitting which is made of opal glass or other translucent material, is now coming largely into vogue, and is the method most commonly used for lighting banks. A good illustration may be seen in the Commonwealth Bank of Sydney. But the effects of this system just as those of direct lighting are lost by dirty bulbs, grimy fittings, reflectors or ceilings. A hardly perceptible film of dust may reduce the effect of lighting by 20 per cent., and a several months' accumulation by 50 per cent.

From tables which have been compiled showing that 75 per cent. of the accidents in factories occur after 4 P.M., and that there is an increase of from 50 to 100 per cent. in the number of accidents during the winter, we may conclude that poor lighting is a contributory cause of accidents, in addition to being injurious to the health and eyesight of workers. Indeed, it is not generally recognized how much eyestrain and headache insufficient and unsuitable lighting causes, nor how prejudicial an effect it exercises on the quantity and the quality of work.

Proper supervision of work and maintenance of cleanliness and general sanitary conditions are only possible with efficient lighting. Statutory provisions requiring adequate and suitable lighting, by defining standards for factories and workshops, are needed for the employee as well as to insure a satisfactory quantity and quality of output of work for the employer. The United States, France, and Belgium are paying considerable attention to legislation with regard to these questions.

For general lighting, regulations such as the following should be adopted:

	Foot Candle at Horizontal Plane of Floor Space
1. Over working areas, without prejudice to that required for the work itself	0.25
2. In all parts of foundries, where any person is liable ordinarily to pass	0.40
3. In all parts of factories and workshops, where any person is liable ordinarily to pass, and not covered by recommendation (1)	0.10
4. In all open places, one hour after sunset and before sunrise where persons are employed, and in any dangerous parts of the regular roads or approaches	0.05

An important accessory to any method of lighting, if the maximum illumination is to be obtained therefrom, is the color effects in the room. It must be a brilliantly lighted room which can dispense with additional light given off by suitable reflecting surfaces. Light colored surfaces are essential to obtain full value for ordinary lighting, where circumstances are such that external or internal conditions interfere with the direct light from the window. In addition to white colored interiors, all obstructing outside surfaces should also be white. The walls of dry areas of basements should be sloped, whitened, and kept constantly clean.

We have found in Sydney that prismatic glass in windows, daylight reflectors, and even prism pavements serve a useful purpose. Borrowed light by means of door panels glazed with ground, prismatic, or other highly reflective glass, are now frequently used in offices and factories. Fanlights for darkened stairways are also useful and should never be obstructed by so-called ornamental glazed paper.

Ventilation

In view of the research of recent years, the whole subject of ventilation has had to be recast. Discomfort with consequent ill health from lack of ventilation, or rather from absence of perflation, is due to the retention of the surplus heat of the body following an increase in the temperature and relative humidity and stagnation of the air. The change which renders air unfit for human beings is a diminished capacity for taking up heat, which is brought about by an increase in the temperature and in the amount of aqueous vapor in the air. It is necessary, therefore, to ventilate rooms, not because of the excess of carbon dioxide that is to be found where persons are confined in an enclosed space, not on account of the lack of oxygen, not primarily because of any mythical organic poison, but first of all to eliminate the superfluous heat from the bodies of the occupants. This has been definitely proved by recent investigations and experiments by Leonard Hill, Haldane, Flügge and others.

Paul, in Flügge's laboratory, shut himself in a glass cabinet and breathed the same air over and over again without discomfort for four hours when the temperature was not above 60° F. and the humidity not above 72 per cent. of saturation. When the temperature was raised to between 68° and 86° F. and the humidity to between 72 per cent. and 90 per cent., serious symptoms appeared in fifteen minutes. Paul measured the surface temperature of his body and found that, with this increase in the temperature of the air, the temperature of his body had increased. Discomfort was relieved when the hot air of the experimental chamber, otherwise unaltered, was set in movement with a fan.

Heat, moisture, and absence of movement in the air acting on the skin are conditions which have to be prevented in order to secure efficient ventilation. The air in an efficiently ventilated room, therefore, must have sufficient motion without causing a chilling draught, and requires constant change to prevent stagnation and over-heating. When the temperature is too high, we need more motion or a larger air supply to keep the body cool. When the temperature is too low, we need less motion or less supply of air to keep the

body warm. This is entirely a surface or skin function which makes the provision of ventilation a physical and not a chemical problem.

In certain industries dust is added to the air and mechanically irritates the breathing mechanism, as in quartz mining and file making. In other processes, lead, mercury, or the fumes of phosphorus affect the workers. Dust consisting of the débris from the wear and tear of articles in use, products of combustion, particles from the skin and from the streets, all add to the impurity of the air of houses and factories. Thanks to wind, rain, and sun, however, the atmosphere in our towns is constantly being purified.

The air of a room or factory, to be satisfactory, must be in a state of constant movement, must be cool, free from disease germs and dust and, above all, must possess a proper degree of relative humidity. When the temperature of the wet bulb thermometer reaches 78° F., continuous work becomes impracticable, and at 88° F. it becomes impossible. The conversion of the indications of the wet and dry bulb thermometer into the mere percentage of humidity which might be comfortable at 60° or 70° would be horribly oppressive at 80° or 90°, and fatal at 100°. On the other hand, at 30° or 40° such a humidity would make conditions intolerably chilly.

Dr. J. S. Haldane relied on the wet bulb readings alone and proposed 70° F. wet bulb as the desirable maximum, and 75° as the temperature which should not be exceeded. Although this is a more satisfactory criterion than the recording of the percentage of saturation, a still more satisfactory method is that introduced by Mr. John L. Bruce of Sydney. Mr. Bruce found that while a wet bulb temperature of 70° or 75° is not oppressive when the dry bulb is 80° or 90°, yet when the air is fully saturated and there is no evaporation — that is to say, when the dry and wet bulb temperatures are identical — a temperature of 70° is very oppressive, and a temperature of 75° almost unendurable, most muggy and oppressive.

Mr. Bruce found that a wet and dry bulb thermometer based upon a constant dew point gave comfortable and desirable conditions at all dry bulb temperatures in New South Wales. So long as the dew point did not rise much above 62° F. the conditions were not unpleasant. Even with a very high dry bulb temperature, bodily vigor was not impaired. With a dry bulb of 111° and a wet bulb of 82°, but with the dew point only 66°, hard work was done without discomfort, although the air was burning hot; whereas with a dry bulb of only 77° and a wet bulb of 75°, but with the dew point 73.5°, the conditions were depressing.

The table of permissible dry and wet bulb temperatures in the New South Wales Factories Act of 1909, as fixed by Mr. Bruce, was based upon a minimum dew point of 57° and a maximum of 67°. This gives a mean dew point of 62° F., at which temperature saturated air is neither muggy nor chilly. When the dew point is from 70° to 75°, exertion becomes difficult, but with the dew point near 62°, even with high wet and dry bulb temperatures, work can be carried on without inconvenience.

Mr. Bruce's records show that the comfortable and invigorating conditions of temperature in relation to moisture in the air are indicated by the dew point rather than by any mere indication of the wet bulb or of the dry bulb alone. By lines drawn from the dry bulb thermometer scale to the wet bulb scale, in such a way that when the mercury in the dry and wet bulb thermometers is at the level of the corresponding ends of the line, a dew point of 62° is indicated on an instrument designed by Mr. Bruce and made by Mr. Esdaile, Hunter St., Sydney. By this instrument the ordinary individual can re-

cord comfortable conditions of temperature and moisture, and can regulate mechanical ventilation in certain industries and factories in accordance therewith.

The Factories Act requires that in every factory in New South Wales the means of ventilation, warming and cooling, to be provided and maintained, shall be such as to keep the humidity and temperature of the air during working hours within the proportions of temperature in relation to moisture shown in Table 1. The relative

TABLE 1.—RELATIVE DRY AND WET BULB TEMPERATURES REQUIRED BY THE NEW SOUTH WALES FACTORIES ACT

Dry Bulb Thermometer Showing Air Temperature in Degrees Fahrenheit	Corresponding Wet Bulb Thermometer Showing Humidity in Air	
	Minimum Fahrenheit	Maximum Fahrenheit
40	35	37
50	44	47
60	53	53
65	60	61
70	63	68
72	64	69
75	65	70
80	67	73
85	68	73½
90	69½	74
95	71	75
100	73	76
105	74	77½
110	75	78½
115	76½	80
120	77½	81

maximum temperatures of the wet bulb thermometer must never be exceeded within the factory or shop except when the humidity in the fresh open air surrounding the factory or shop is so excessive that it shows an increase in those relative temperatures. On such occasions the wet bulb temperature within the factory may be increased, in the same proportion as that shown by the open air. If for any special manufacturing process or storage purpose any occupier desires the air in his factory workshop to be saturated with moisture beyond the proportions shown by the relative temperatures given in Table 1, he must make written application to the Minister for special permission to do so, specifying the conditions as to temperature and moisture which he desires.

The only case of exemption under the Factories Act in New South Wales, in which the relative maximum temperature of the wet bulb thermometer is permitted to be exceeded, is in a large tobacco factory. This factory, one of the most up-to-date in Australia, with a large amount of window space, requires for manufacturing purposes an even, moist temperature. In hot weather, when northwest winds prevail, windows can be freely opened, but when the dry, westerly winds are blowing, the means of ventilation cannot be fully utilized, as the leaf becomes too dry to handle readily. Readings taken by Miss Harriott, Senior Inspector, with a wet and dry bulb thermometer, showed that the humidity of the atmosphere in the "rolling" department slightly exceeded that allowed by the Factories Act. I was therefore called in to investigate, and at my recommendation a certificate was given permitting the company to vary the temperature of the wet bulb in the "rolling" department, so long as it did not exceed by more than 3° the temperature indicated in the regulation. This company is probably the best exponent of welfare work among employees, in New South Wales, and only avails itself of the concession when exceptional weather conditions render it necessary.

For natural ventilation the rule is generally laid down that openings for the exit of foul air should average 24 square inches for each individual. Where the openings for fresh air are larger than those for the exit of foul air, and are placed 5 or 6 feet from the floor, possibilities of draught are minimized. Hitherto, sufficient use has not been made of the natural ventilation obtained by leaving a space between the upper portion of the wall and the roof of buildings. It is a good rule, in factories, to

invest one person with the responsibility of seeing that windows are kept open and of prohibiting the closing of windows except to prevent rain or dust from driving into the room. With this proviso, in most cases natural ventilation should be sufficient, except on days with relatively high humidity, when it is necessary to supplement it by mechanical movement of the atmosphere, as by electric fans.

The difficulty of ventilating factories, largely due to the accumulation of pockets of foul air, especially toward the center of large rooms, can only be entirely satisfactorily removed by mechanical means, the best of which appears to be a combination of the plenum and vacuum systems. Where there is special risk from dust, fumes, or gases, owing to the nature of the employment, strong exhausts and hoods are necessary at the points of production.

Modern factory managers who have studied the recent investigations of the Munitions Health Committee must realize that the better the ventilation the better the health of the employees and the better the work performed.

Hours of Labor and Health

A remarkable feature of the earlier years of the War, when it was necessary in England to concentrate on the organization of munition works, was that for a time, by mutual agreement of employers and employees, the restrictions as to hours of work were withdrawn, and men, women, young persons, boys and girls, all worked at high pressure, the stimulus of national necessity being backed up by high remuneration. What was the result? It was found that such extensive concentration on work for long hours did not pay and that Sunday labor, that is, the lack of one day's rest in seven also did not pay.

Certain employers who kept a careful record found that output not only was not increased by the seven-day working week, but that it actually declined after the first few months. The six-day working week was then restored. It was found, however, that the considerable increase of overtime was telling on the workers, as evidenced by the amount of lost time from sickness. With improved management of the factories, it was soon realized that more work was actually done in an eight-hour day than in a ten-hour day.

The results of the investigation by the Scientific Research Committee appointed to review the operations of munition workers, and the collection of data as to the occurrence of fatigue, showed that the output in certain industries followed the same curve as that of a muscle stimulated by a galvanic current. It was found that, just as nature observes rhythm and prescribes periods of rest, so, in order to obtain maximum efficiency in industry, it is necessary to observe as closely as possible the prevention of excessive fatigue beyond the point recoverable by a reasonable period of rest. The old adage of "all work and no play makes Jack a dull boy" was again exemplified in industry. It was found that in mechanical industries the output increased at a certain period of the day and then declined; then increased again, after an interval for a meal, then declined; and, in some industries, then increased for the last hour in an eight-hour day, but in a ten-hour day steadily declined. Another interesting point noted was that where there was machinery the incidence of accidents increased as the period of fatigue was reached.

The Industrial Fatigue Committee of the United States Council of National Defence, after an elaborate investigation by the Division of Scientific Research of the Public Health Service to discover in munitions factories the conditions under which a maximum continuous output might be obtained, discovered that while it is often

possible to increase output temporarily by increasing the work of the employee, if he be overworked, the output soon falls off. Such a method quickly defeats itself and is not profitable in the long run. Given adequate equipment and administration of the plant with a proper spirit among employees, fatigue was found to be the greatest single obstacle to a maximum output. Fatigue diminishes output both directly and also indirectly by increasing accidents, sickness and the proportion of spoiled work.

In addition to the mere recording of a falling off of output per individual per hour, day, or week — according to the duration of the working period — the comparing of averages per hour under different schedules of work, and the estimating of the fall in the amount of electrical or other power consumed due to other causes than temporary stoppage, of the amount of spoiled work, and of the number of absences from accidents and sickness, various tests of fatigue were supplied by investigators in the laboratory and applied to industries. These tests concern the muscles, the nervous system, sight, hearing, and certain chemical changes within the body. Consideration was also given to the living conditions of the workers and to their habits as to recreation outside the factories, although fatigue due to outside conditions is obviously less easily controlled than that caused by work inside the factory.

The introduction of obligatory resting periods during a working spell is well illustrated in Australian Shearing Sheds by the "Smoke O." You must have often read during the War that so and so did exceptional service for a continuous period under heavy fire, etc., for forty-eight or seventy-two hours. With regard to stretcher bearers, one read of men being continuously on duty for days during a heavy engagement. My experience was that such overwork did not pay as the men speedily became fatigued. Therefore, when I was put in charge of the evacuation of wounded of the Third Australian Division for the Battle of Messines, and had to plan for the removal of the wounded from four Regimental Aid Posts, I made arrangements to work in shifts the 308 stretcher bearers of the ninth, tenth, and eleventh Field Ambulances who were at my disposal. I insisted on half the men resting for the first twelve hours after zero, the moment of attack. Consequently, after twelve hours of strenuous work we had a fresh group of men to carry on. Then, after the second twelve hours, those not casualties in the first group were able to carry on, and in this way we managed to keep up the work for six days and nights.

It was also found during the War that a five minutes' halt for a breathing spell at the end of each hour of marching was an advantage for both man and beast.

It was the experience in American factories, likewise, that five-minute resting periods in a working spell, or, where this was not possible, a single recess of ten or fifteen minutes' duration, increased the output, especially if a cup of cocoa or milk was served to the worker. The resulting increased efficiency yielded equal, if not greater output.

The introduction of variety into work also diminishes fatigue. Anyone who has seen a girl labelling tins, wrapping up soap, or performing some other mechanical work, can realize that if she were trained to do some alternative process so that she could temporarily interchange work with another girl, fatigue could be diminished without lessening output.

Adjusting the Speed.—When a single motor operates a number of machines the speed may more easily be adjusted to the average pace if an exceptionally fast or slow worker is transferred to another job, in order that the same rhythm may be secured throughout the squad. Fatigue is least when the customary rhythm is main-

ained, and the output may be twice as great as when the speed is a little slower or a little faster than this customary rhythm. It was noticeable in Lever Bros. works at Balmain, Sydney, that the incentive of piece rates in certain branches kept up a high rate of output.

Omitting Unnecessary Motion. — It was also noticeable at Lever's works that the placing of the packages, which the workers had to handle, at a convenient height and distance from their hands prevented unrhythmical, unnecessary motions or undue muscular exertion, and thus caused the work to be done automatically with the least possible waste of energy and time.

Alternating Day and Night Work. — The British Health of Munition Workers' Committee, after a careful statistical study of output, found that where the same night shift continued in employment the total output was less than where there was an alternation of day and night work. This was true of both men and women. The alternating periods of night work should not, however, be less than one month in duration, as frequent changes of habit might be deleterious to health.

With regard to the workers in the cleansing department of the Sydney City Council we find that it is advisable periodically to change men on the night shift to day work and *vice versa* as a means of keeping down loss through sickness, especially neurasthenia, gastritis, and bronchitis.

Adjusting Hours of Work. — The British Health of Munition Workers' Committee found that it was a mistake to recommend a uniform day for all kinds of work. The most profitable duration of the working period for women and boys, even when employed on shift work, was found to be less than for men. It is obvious that a man can do more work in two hours than in one hour, but it does not necessarily follow that he can do more work in twelve hours than in ten hours, or more in ten hours than in eight hours, or in some arduous occupations, more in eight hours than in six hours, over a lengthened period. Whenever the work is of such duration as to cause pronounced fatigue, it has been shown again and again that after some time shortening the working period actually increases the amount of work done.

A granite-cutting company found that "the same man under identically the same conditions accomplished more of exactly the same kind of work when he was working nine hours than he did when he was working ten hours. And again, when the hours were reduced to eight hours, this same man accomplished still more in an eight-hour day than he did in a nine-hour day, or a considerable amount more than he did when the day was ten hours long."

In one English munition factory the average weekly hours of men sizing fuse bodies were reduced from 58.2 to 51.2 with a total increase of output of 21 per cent. Another munition factory — one of the largest in England during the War, employing 70,000 workers — gave its employees a whole holiday on Saturday instead of a half day, owing to numerous absences from work. As a result, the absences were diminished by 50 per cent., and consequently the firm has continued the custom.

Although the abolition of Saturday work among the 3,000 employees of the Sydney City Council is only a recent venture, it is an interesting fact that never have I had so few men reporting sick as during the last eight weeks. Thus, the saving in money in paying men during absence from sickness, as is the practice of the Sydney City Council, may in the end pay for this innovation which is so much appreciated by both the indoor and outdoor workers. The fact that a man knows that he has two days' leisure at the end of the week often makes him remain at his job until Friday; moreover, for the same reason, men now come up on Friday to sign on again to start

work on the following Monday instead of waiting until 9 o'clock on Monday morning for medical examination, which would generally mean that they could not start work until Tuesday.

Avoiding Overtime. — If the usual day's work stops just short of undue fatigue, overtime means overwork. Overtime work is apt to result in an increased amount of spoiled work and in lessened output, as well as in an increased number of absences on subsequent days, and is, consequently, unprofitable, particularly in view of the increased rate of wages that must be paid.

It has been very noticeable to me, especially in the Electric Lighting Department of the Sydney City Council, where, owing to certain circumstances, it has been necessary for men to work considerable amounts of overtime and in some cases to do double shifts, that we have had a number of cases of neurasthenia and gastritis, especially in the summer months. In some cases men were absent through sickness, largely the result of over-fatigue, treble and quadruple the time they worked overtime. Overtime should only be resorted to in exceptional emergencies and even then not for many days in succession. Even in agricultural work, a tired worker who has not had time to recuperate cannot do himself or his employer justice.

BOOK REVIEWS

INDUSTRIAL FATIGUE AND EFFICIENCY. By H. M. Vernon, M.A., M.D., Investigator for the Industrial Fatigue Research Board; Late Fellow of Magdalen College, Oxford. Cloth, Pp. 264 with index. London: George Routledge & Sons, Ltd.; New York: E. P. Dutton & Co., 1921.

This book constitutes a thorough discussion of our field knowledge of industrial fatigue. It is not concerned with laboratory material, but has been compiled with a thorough appreciation of the significance of laboratory results.

The opening chapter gives the author's conception of the problem. He accepts fatigue as the necessary result of work and considers that from the point of view of industrial hygiene one should search first of all for evidence as to whether the "fatigue induced by an industrial occupation has an unfavorable influence on the health of the worker." It is recognized that effects on health may take weeks, months or even years to appear, and that consequently the essential problem of industrial fatigue is most difficult. As a second and somewhat less important endeavor, search should be made for sources of "unnecessary fatigue." It is clearly unwise to add useless dissipation of energy to the routine of daily labor. Such a point of view has nothing to do with requiring an honest day's work. It simply means that every effort should be made to increase productivity through conservation of unnecessary labor.

The author regards it as highly improbable that any single test will ever give valid measurements of fatigue in diverse occupations and, as a consequence, comes to the conclusion that "the only satisfactory test at present available is one based on the performance of the operation itself."

In studying different operations the working capacity has been measured in terms of hourly, daily and weekly periods in many different industries and under varied hours of work, rest periods, etc. Chapters concerned with such data are followed by others upon lost time and its causation, the prevention of industrial accidents, and factory conditions. The introduction to the final chapter on practical conclusions sums up the attitude which in a general way governs the presentation of the material: "Up to a certain point fatigue is a natural physiological condition, which is inevitably incurred as the result of industrial work, and it does good rather than harm to the worker. Beyond this point it becomes pathological and acts injuriously upon him, but the pathological condition arises so gradually out of the physiological, and the evil effects produced at first may be so slight, that it is often quite impossible to put a finger on the line of demarcation. Often one can judge only by the cumulative effects of the over-fatigue, which may take weeks, months, or even years, to reveal themselves beyond question, and then it may be too late to effect a remedy. Hence the employer of labour who wishes to avoid all industrial conditions which injure the health of his employees, and the investigator who wishes to advise on the means of attaining this end, often have to act, or suggest action, on general principles. They may not be able to adduce specific reasons which can be substantiated by a direct appeal to the industry or occupation under consideration. . .Let the conditions suggested by a study of other industries be adopted. Some of them can be followed boldly and without question, whilst others, about which less certainty exists, should be pursued cautiously, in gradual stages. Let the effects of such changed conditions be carefully studied, not for a few weeks only but for many months, till definite conclusions can be drawn. That is to say, every substantial change in industrial conditions ought to be regarded as an experiment, the effects of which should be carefully ascertained, not only because of their immediate interest to the employer who has made them, but because they concern everyone who is in any way connected with the industry in question, and to a less extent those connected with other industries. The secret of progress in the science of industrial fatigue is the adoption of the *experimental method*, and the rate of progress depends very largely on the interest and co-operation of employers." This point of view has often been lacking both in the collection and presentation of data upon industrial fa-

tigue. The subject is so closely bound with economic and sociological questions as to cause investigators to look for certain things rather than to view the problem with the detachment it requires.

Dr. Vernon's book will serve as a useful text for all those who are teaching this subject to students of college and graduate grade. Many references are given, and indexing is fairly complete. A most commendable feature is found in the close proximity of charts and tables to the text discussing them. It is seldom that one finds a volume in which this desirable feature of successful printing is so well arranged.—*C. K. Drinker.*

BOOKS RECEIVED

Books received are acknowledged in this column, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

PUBLIC HEALTH AND HYGIENE. In Contributions by Eminent Authorities. Edited by William Hallock Park, M.D., Professor of Bacteriology and Hygiene, University and Bellevue Hospital Medical College, and Director of the Bureau of Laboratories of the Department of Health, New York City. Cloth. Pp. 884, with illustrations and index. Philadelphia and New York: Lea & Febiger, 1920.

ESSENTIALS OF LABORATORY DIAGNOSIS. Designed for Students and Practitioners. By Francis Ashley Faught, M.D., formerly Director of the Laboratory of the Department of Clinical Medicine and Assistant to the Professor of Clinical Medicine, Medico-Chirurgical College, etc., Philadelphia, Pa. Seventh Revised and Enlarged Edition. Cloth. Pp. 523, with illustrations and index. Philadelphia: F. A. Davis Company, 1921.

RINGWORM AND ITS SUCCESSFUL TREATMENT. By John P. Turner, M.D., Medical Inspector of Public Schools, Philadelphia, Pa. Cloth. Pp. 62, with index, foreword, introduction and illustrations. Philadelphia: F. A. Davis Company, 1921.

ANNOUNCEMENT OF

THE AMERICAN ASSOCIATION OF INDUSTRIAL PHYSICIANS AND SURGEONS

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Can YOU as a physician afford not to be interested in INDUSTRIAL MEDICINE?

If you are holding an industrial position, however important, however small, you will get more out of it and put more into it if you belong to the AMERICAN ASSOCIATION OF INDUSTRIAL PHYSICIANS AND SURGEONS. This Association can serve you—

1. In the study and discussion of problems, national in scope, peculiar to the practice of industrial medicine and surgery.
2. To develop methods adapted to the conservation of health among workers in the industries.
3. To promote a more general understanding of the purposes and results of the medical care of employees.
4. To unite into one organization members of the medical profession specializing in industrial medicine and surgery for their mutual advancement in the practice of their profession.

MEMBERSHIP from now until the close of our fiscal year, May 1, 1923, will cost you only $6.00. Yearly dues are $5.00.

There are three classes of membership—Active, Associate, and Honorary.

Active Members. Physicians who are actively engaged part or full time in the practice of industrial medicine and surgery, or who are engaged in the investigation of industrial medical problems.

Associate Members. Physicians INTERESTED in industrial medicine. (Entitled to all the privileges of the Association except voting and holding office.)

Honorary Members. Persons who have contributed distinguished service to the objects for which the Association stands.

Membership entitles you to: (*a*) Our official journal, *The Nation's Health*, which contains full reports of all the affairs of the Association, together with other interesting articles on industrial medicine. (*b*) Bi-monthly abstracts of current industrial medical literature. (*c*) Reports and digests of interest to those engaged in industrial work.

REMEMBER THE DATE OF THE ANNUAL MEETING, MAY 22, 23, ST. LOUIS, MO.

(The same week as the A.M.A. Meeting.)

CENSUS OF SAFETY AND HEALTH WORKERS

All industrial physicians and surgeons, industrial nurses, and other persons engaged in industrial health work are to be included in the census of safety and health workers now being taken by the National Safety Council in all parts of the country. Although health work in industry, along with safety, has made great strides in the past few years, it is not at present known how many persons are engaged in either of these activities, who they are, or where they are located. This is the first time an attempt has ever been made to list all the industrial safety and health workers. Public safety workers will also be included in the census.

It is believed that the results of the census will give a good indication of how extensive the safety and health activities now being carried on are. The census will include not only members and employees of members of the National Safety Council, but all persons engaged in industrial safety and health work whether connected with the Council in any way or not. The Council has almost as deep an interest in industrial health work as in accident prevention, and is very closely allied with the American Association of Industrial Physicians and Surgeons. Many health workers and companies employing health workers are numbered among the Council's membership.

Industry in general and the nation at large will profit from the results of this census. It will enable the Council to find quickly speakers on industrial and public safety for any occasion in any locality; authors for special articles on accident prevention; writers of safety text-books; lecturers on accident prevention and industrial health work for universities and colleges. The Council at present continually receives requests from industrial companies, municipalities, civic associations, clubs, schools, colleges, and other organizations for help in finding speakers or writers on safety subjects. The census records will greatly increase the facilities of the Council for filling such requests.

Every reader of this publication who is professionally engaged in industrial or public accident prevention or industrial health work — whether he is devoting all or only part of his time to accident prevention — is urged to assist in the taking of this census by sending to the National Safety Council, 168 North Michigan Avenue, Chicago, his name and the other data requested in the Council's census form, which follows:

Name .....

Company or organization .....

City ..... State .....

Nature of company's business .....

Is safety your principal work? .....

Please check other activities you engage in:

Fire protection	Engineering (other than safety)
Health and sanitation	Legal
Workmen's compensation and claims	Insurance
General executive (such as manager or superintendent)	Welfare Educational
	Industrial relations

How long have you been in your present position? .....

Technical or other special education? .....

Signed .....

Title .....